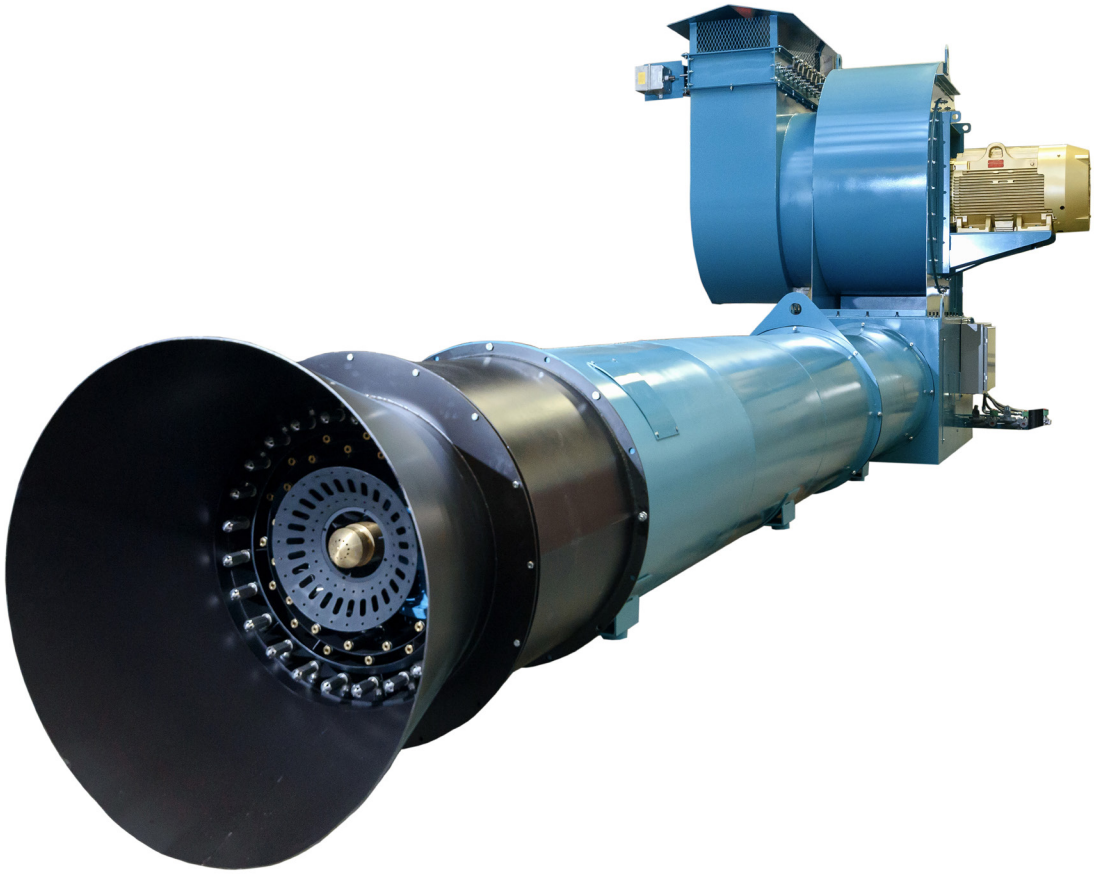
WEBSTER COMBUSTION
A Selas Heat Technology Company

Webster Combustion Technology
619 Industrial Road, Winfield, KS 67156

Installation, Startup, Operation and Maintenance Manual

HDRA-RF Series Multi-Fuel Burners For The Asphalt Industry



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SAFETY PRECAUTIONS

Good safety practices must be used when working on burner equipment. The potential energy in the electrical supply, fuel and related equipment must be handled with extreme care to prevent equipment failures, injuries and potential death.

Throughout this manual, the following symbols are used to identify potential problems.

WARNING

This indicates a potential hazardous situation, which if not avoided, could result in personal injury or death.

CAUTION

This indicates a potentially hazardous situation, which if not avoided, could result in damage to the equipment.

The following general safety precautions apply to all equipment work.

WARNING

IF YOU SMELL GAS, EXTINGUISH ANY OPEN FLAMES, STAY AWAY FROM ELECTRICAL SOURCES, EVACUATE THE AREA, AND IMMEDIATELY CALL THE GAS COMPANY.

IN ACCORDANCE WITH OSHA STANDARDS, ALL EQUIPMENT, MACHINES AND PROCESSES SHALL BE LOCKED OUT PRIOR TO SERVICING.

IF THIS EQUIPMENT IS NOT INSTALLED, OPERATED AND MAINTAINED IN ACCORDANCE WITH THE MANUFACTURERS INSTRUCTIONS, THIS PRODUCT COULD EXPOSE YOU TO SUBSTANCES IN FUEL OR FROM FUEL COMBUSTION WHICH CAN CAUSE DEATH OR SERIOUS ILLNESS AND WHICH ARE KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER, BIRTH DEFECTS OR OTHER REPRODUCTIVE HARM.

IMPROPER SERVICING OF THIS EQUIPMENT MAY CREATE A POTENTIAL HAZARD TO EQUIPMENT AND OPERATORS.

SERVICING MUST BE DONE BY A FULLY TRAINED AND QUALIFIED PERSONNEL.

BEFORE DISCONNECTING OR OPENING UP A FUEL LINE AND BEFORE CLEANING OR REPLACING PARTS OF ANY KIND:

- **TURN OFF THE MAIN MANUAL FUEL SHUTOFF VALVES.**
- **TURN OFF ALL ELECTRICAL DISCONNECTS TO THE BURNER AND ANY OTHER EQUIPMENT OR SYSTEMS ELECTRICALLY INTERLOCKED WITH THE BURNER.**

Service Organization Information:

Company Name _____

Address _____

_____

Phone Number _____

Date of Startup

_____

Lead Technician

_____

HDRA-RF MANUAL TABLE OF CONTENTS

SECTION 1: GENERAL INFORMATION

The Webster HDRA-RF Low NOx Burner for rotary drying of aggregate is a total air register type burner equipped with Dynamic Flame Shaping™ to automatically match the flame to the drum while the plant is running. Low emissions and quiet operation make the burner ecologically friendly and able to conform to most state's emissions regulations.

The HDRA-RF is an extremely efficient burner capable of burning natural gas and all grades of commercially available fuel oil, including RFO. When firing on oil, the burner utilizes compressed air atomization to achieve efficiency and low emissions.

Precise control of the burner is provided by the Webster ABMS Asphalt Burner Management System. The ABMS is a PLC platform with HMI interface specifically engineered to control the HDRA-RF.

The HDRA-RF has proven to offer reliable and trouble-free operation to ensure the plant meets its production requirements day in and day out.

Dynamic Flame Shaping™

Dynamic Flame Shaping™ refers to the HDRA-RF's ability to increase or decrease the amount of swirl in the air flow to shape the flame. More swirl = shorter flame. Less swirl = a longer flame.

The register is a servo motor operated vane assembly located at the front of the burner nose. DFS™ matches the flame shape to the dryer and automatically controls the flame shape throughout the entire firing range of the burner.

The vanes are interconnected by a linkage system controlled by a servo motor directly coupled to the shaft. The servo motor modulates the vanes in relation to burner output. The Webster HDRA-RF series of aggregate dryer burners is the first and only burner on the market with real time flame adjustment.

Benefits of the HDRA-RF Multi-Fuel Asphalt Burner

The Webster Combustion model HDRA-RF is a register-style burner that allows users to shape the flame by automatically controlling the register vanes to optimally fit their dryer and combustion zone. This allows the Webster burner to operate with a shorter flame than products of other aggregate burner manufacturers. This flame-shaping capability means the flame will not impinge on the material, and CO can be maintained at much lower levels than currently available. In addition, NOx levels for the HDRA-RF are significantly lower than typically seen in asphalt applications

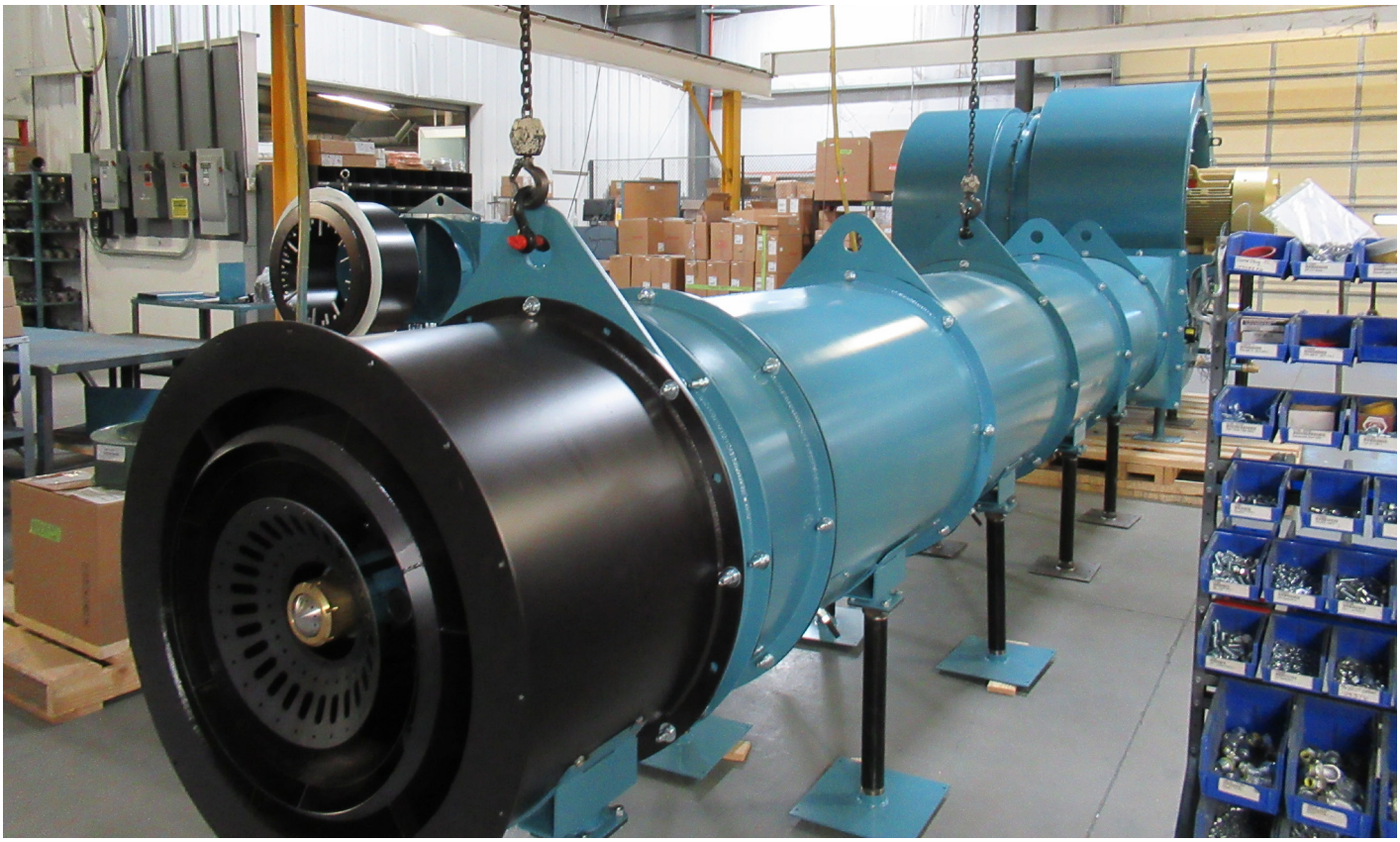
The Webster Combustion HDRA-RF burner readily adapts to mount on both Parallel Flow and Counter Flow Dryers, and the burner housing and fan can be installed in multiple configurations depending on space constraints and elevator location.

The Webster Combustion HDRA-RF Series Asphalt Burner is capable of burning a wide range of fuels including Natural, LP, and low BTU gas, all commercially available grades of fuel oil, and qualified waste oils. A dual manifold combustion head is available for applications firing multiple gas fuels.

Features of the HDRA-RF Burner

- Excellent flame stability for reliable performance
- Low excess air for extremely efficient operation
- Fully modulating register for automatic flame shaping
- Low NOx emissions
- High turndown rates
  - Up to 10 to 1 on Gas firing
  - Up to 8 to 1 on oil firing
- High combustion efficiency
- Fire multiple fuels
  - Natural, LP, or Digester gas
  - No. 2 through No. 6 Oils and RFO
- Configurable blower housing to match application requirements
- Long Nose options available
- Proven ignition system with an extremely stable pilot
- High efficiency combustion air fans to optimize electrical needs
- Access doors for easy service of firing head and fan for maintenance
- Optional VFD and inlet air damper for precise air control
- Air atomized oil systems may include an optional air compressor supplied with the burner package

SECTION 2: RECEIVING AND INSPECTING



Receiving & Inspection

Upon receipt, check each item on the bill of lading and/or invoice to determine that all equipment has been received. A careful examination of all parts should be made to ascertain if any damage has occurred during shipment.

If the installation is delayed and the equipment is stored outside, provide adequate protection as dictated by climate and period of exposure. Special care should be given to all motors and bearings, if applicable, to protect them from rain or excessive moisture.

Rear-mounted junction box exterior

SECTION 3: BURNER CAPACITIES

Table 3.1 Burner Capacities

Burner Model		HDRA-RF*-50	HDRA-RF*-75	HDRA-RF*-100	HDRA-RF*-125	HDRA-RF*-150	HDRA-RF*-175	HDRA-RF*-200
Capacity	MMBTU/hr	50	75	100	125	150	175	200
Combustion Air Fan Flow	CFM	14520	21780	29040	36300	43550	50810	58070
Combustion Air Fan Pressure	Inches W.C.	11.9	14.5	11.7	17.3	14.6	11.4	14.4
Gas Flow Rate	SCFH	50000	75000	100000	125000	150000	175000	200000
Oil Flow Rate	GPM	5.9	8.9	11.8	14.8	17.7	20.7	23.6
Flame Length, No Spin	ft	9.3	12	13.1	16.3	17.1	17.2	19.6
Flame Diameter, No Spin	ft	2.9	3.8	4.1	5.1	5.4	5.4	6.2
Compressed Air Flow Rate (Oil Firing Only)	SCFM	47	70	93	116	139	162	185

Notes:

1) Burner capacity is based on 60 Hz power, 1,000 FASL elevation, and 90° Fahrenheit air temperature. Correction factors must be applied for variations in altitude, temperature, or frequency. Consult the factory for more information.

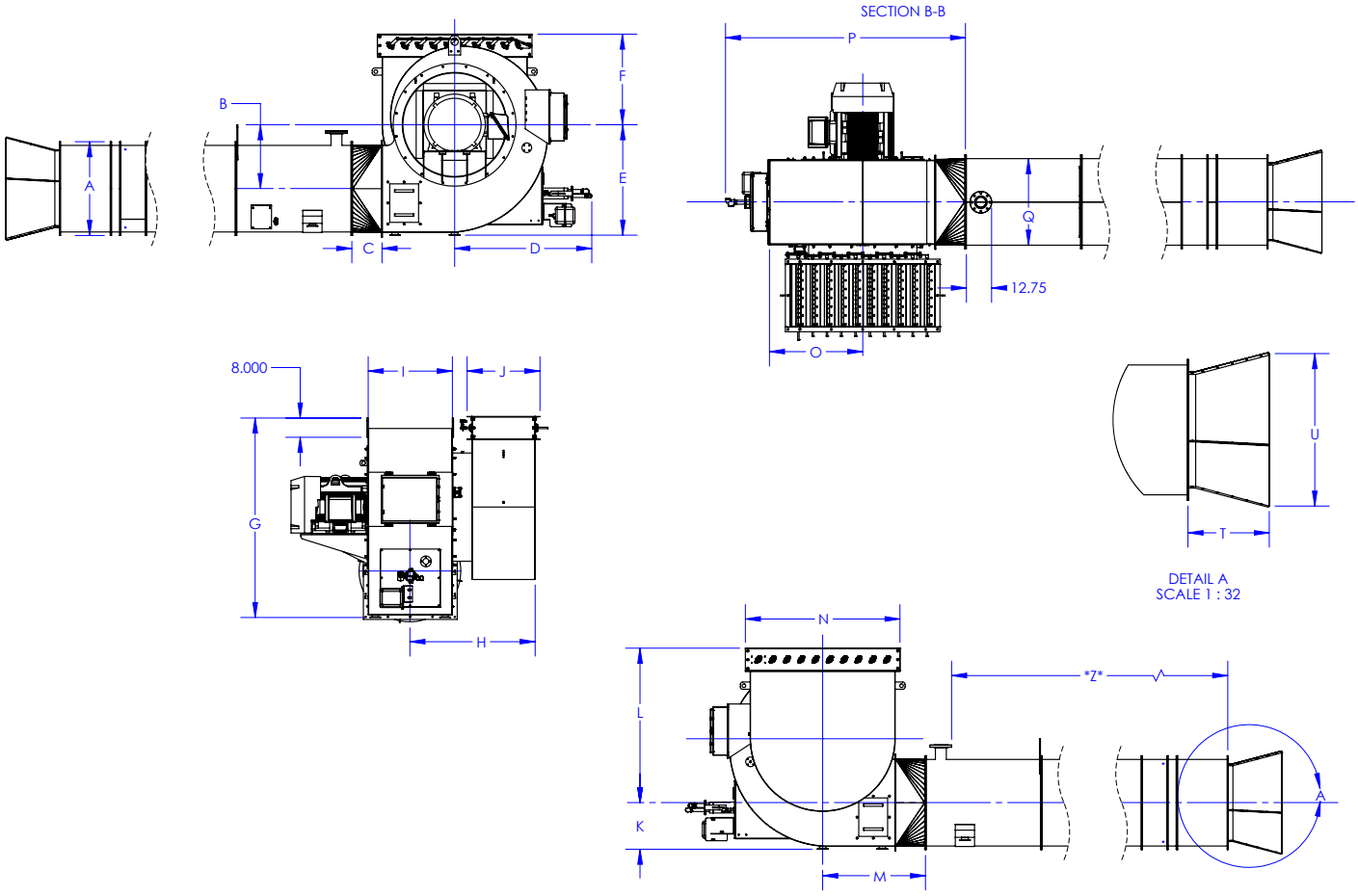
2) Natural gas flow rate based upon 1,000 BTU/SCF HHV (Higher Heating Value) natural gas.

3) Fuel oil capacities based on 141,000 BTU/gallon #2 fuel oil.

4) The exhaust fan must be able to provide a negative pressure in the combustion zone in the range of -0.25"w.c. to -1.0"w.c. at full burner capacity.

5) Compressed air for fuel oil firing must be provided at minimum 100 psig at the entrance to the compressed air train.

HDRA-RF Series Typical Dimensions and Ratings



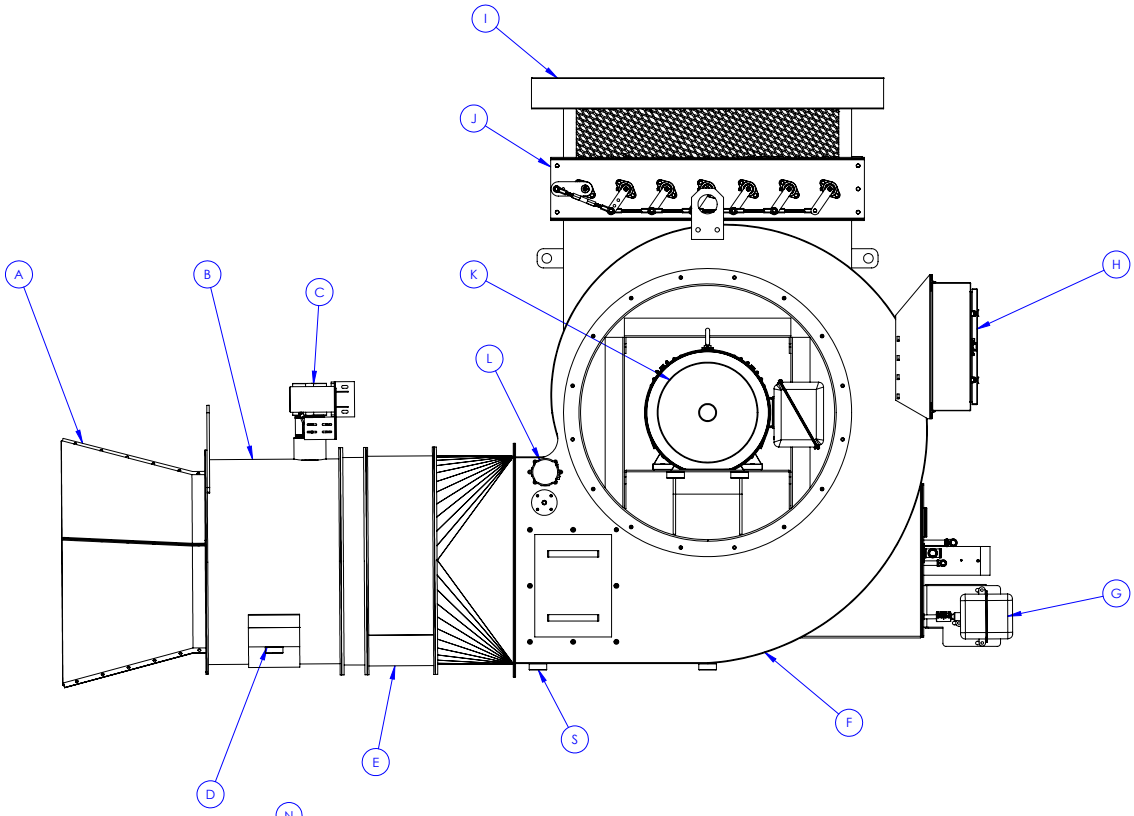
BURNER MODEL	DIMENSIONS – INCHES																			
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	T	U	*Z*
HDRA-RF*-50	27	24	7	49.5	37	32	68	32	22	17	14	56	26.3	43	32	84	24	18.6	27.6	48.5
HDRA-RF*-75	30.2	26.5	10.2	53.5	41.3	39.7	74.4	42	32	22	14.8	60	36.1	45.4	35	92.2	27.2	21	32.1	48.5
HDRA-RF*-100	35.1	25.6	10.2	56	42.8	39.7	77	48	32	28	17.2	59	39.2	45.4	36	93.7	32.4	24.9	39	48.5
HDRA-RF*-125	35.1	26.6	10.2	55.8	43.8	35.25	80.25	51.6	35.3	28	17.2	61.8	41.4	49.5	37.3	97.2	37.3	24.9	39	48.5
HDRA-RF*-150	39.1	26.6	10.2	57.1	45.8	35.25	82.9	51.6	35.3	30	20.9	61.8	42.2	49.5	38.6	99.3	36.4	24.9	43.1	48.5
HDRA-RF*-175	44.1	27.7	10.2	60.3	47.8	35.9	86.9	55.5	39	32	21.8	65.2	45.4	54	41.8	97.3	41.4	24.9	48.1	48.5
HDRA-RF*-200	44.1	28.6	10.2	60.3	42.8	37.4	86.6	55.5	39	32	21.8	66.7	45.4	54	41.8	105.7	41.4	24.9	48.1	48.5

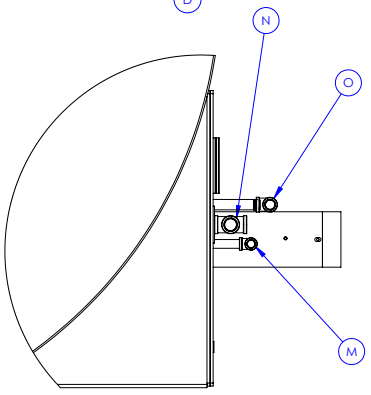
NOTE: *Z* is the minimum nose required.
Custom insertion depths available. All dimensions are reference only.

Dimensions are for reference only and will change to suit the requirements of the burner order. Do not use these dimensions for construction. A dimensional drawing is included with every burner. Refer to the order dimensional drawing for accurate dimensions.

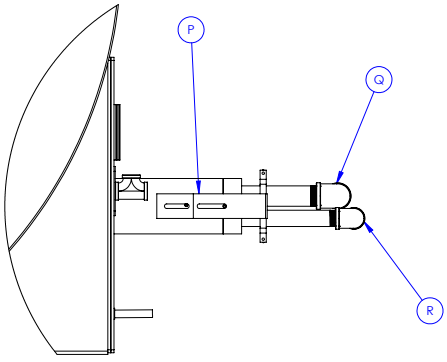
5. COMPONENT IDENTIFICATION

This section describes the components of the HDRA burner line and provides some details on their application and operation. Other sections of this manual provide a more detailed review of how the components work as a system and explain the overall operation of the burner.





GAS ONLY



OIL/COMBO

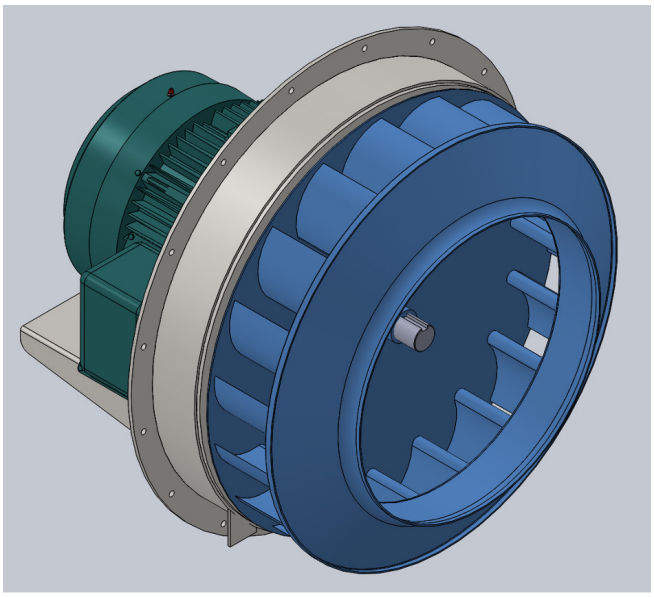
A – Burner Exit Cone	B – Fuel Gas Manifold
C – Fuel Gas Entry / Gas Valve	D – Support Saddle
E – Dynamic Flame Shaping Register	F – Fan Housing
G – Dynamic Flame Shaping Register Servo	H – Electrical Junction Box
I – Rain Hood	J – Louver Box
K – Fan Motor	L – Air Flow Switch
M – High Voltage Igniter Cable Entry	N – Scanner Cable Entry
O – Pilot Gas Entry Q – Atomizing Air Entry	P – Oil Gun Bracket
Q – Atomizing Air Entry	R – Fuel Oil Entry

6.1 Fan

A backward curved fan is used to supply the combustion air to burn the fuel. The fan diameter and width will vary to match the required combustion air flow rate. The fan operates at 1800 rpm. An inlet cone is used with the fan to provide a smooth air flow transition to the fan. Each fan has a matching inlet cone. The inlet cone bolts directly to the air housing.

6.2 Fan and Motor Assembly

The combustion air fan and motor are assembled on a motor support plate that attaches to the fan housing. This assembly, as shown in the figure below, is built and balanced as a sub-assembly that can be removed for maintenance and repair. The fan has a hub that is machined to match the motor shaft diameter and key. Setscrews or a keyway are used to lock the fan to the hub. The fan can be adjusted on the shaft to provide the correct overlap between the fan and inlet cone (see below table). A TEFC (Totally Enclosed Fan Cooled) type motor would typically be used in a dirty or wet environment. Other styles are also available for special applications. The motor dimensions, including the shaft diameter will vary by motor size..

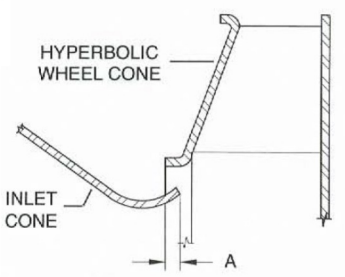


Fan, motor and motor mounting plate

6.2.2 Fan Motor & Cone Overlap

Combustion air control is achieved through either an air louver, a VFD (Variable Frequency Drive), or both working together. The VFD controls the fan speed, increasing or decreasing the total combustion air flow into the burner. The air louver opens and closes, driven by a servo connected to the burner control system, increasing or decreasing the total combustion air flow into the burner.

DESIGNS 41 AND 62

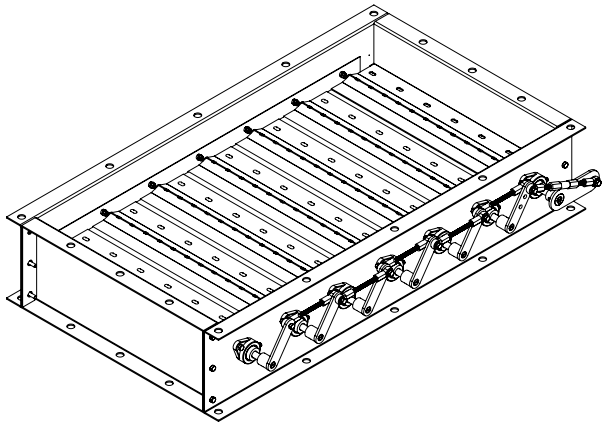


Fan Design D/62 Size	Fan Design D/41 Size	Overlap A (In.)
100	875	3/8
122	1000	3/8
135	1225	3/16
150	1350	1/4
165	1500	1/4
182	1650	5/16
200	1825	3/8
222	2000	7/16
245	2225	1/2
270	2450	9/16
300	2700	11/16
330	3000	13/16
365	3300	1
402	3650	1-1/32
445	4025	1-1/32
490	4450	1-11/32

6.3 Combustion Air Control

Combustion air control is achieved through either an air louver, a VFD (Variable Frequency Drive), or both working together. The VFD controls the fan speed, increasing or decreasing the total combustion air flow into the burner. The air louver opens and closes, driven by a servo connected to the burner control system, increasing or decreasing the total combustion air flow into the burner.

For superior air control, utilize both a louver box and a VFD; together, they provide the most accurate flow, highest efficiency, and best performance.



Air louver assembly–
For superior air control, utilize both a louver box and a VFD; together, they provide the most accurate flow, highest efficiency, and best performance.

7. BURNER MOUNTING

7.1 For exact dimensions and layout, refer to the general arrangement drawing included with the submittal package of the burner.

7.2 The burner shall be mounted on the drum centerline at the same pitch as the drum.

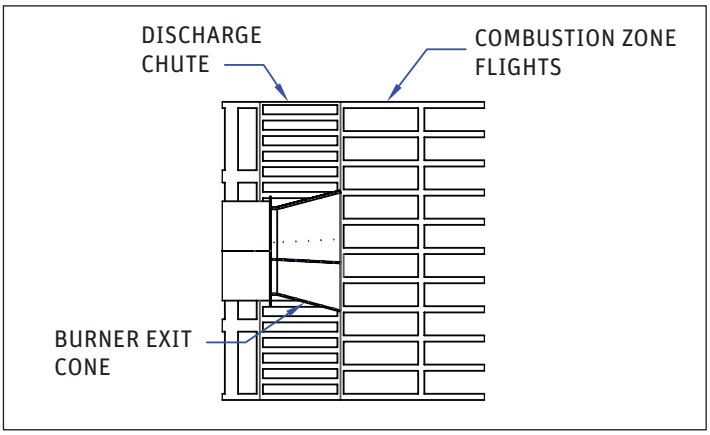
7.3 The burner shall be well supported. A support structure shall be built to support the weight of the burner at four support points beneath the burner. The nose of the burner shall be supported. Standard nose burners shall be supported at a saddle support as part of the support structure. Extended or long nose burners may have multiple saddle supports on the nose of the burner, and they shall be supported at each saddle point by the support structure, a secondary support structure, or by the vessel in which the burner is mounted. The burner is not designed for the nose to be unsupported.

7.4 The burner shall be aligned within the combustion zone such that:

7.4.1 No material shall tumble or fall in front of the burner exit cone or into the burner flame.

7.4.2 No feature or projection of the equipment shall be within the combustion zone such that the burner flame may impinge upon it or may damage it.

7.4.3 The burner shall be protected from falling aggregate, sand, gravel, etc.



Typical Alignment of the Burner in an Aggregate Dryer

7.5 The burner shall be lifted at three points minimum: the two lifting eyes atop the fan housing and the removable lifting eye on the burner nose.

7.6 The burner shall be firmly bolted to the support structure.

7.7 Wire the burner in accordance with the wiring diagram included with the submittal package of the burner. If the burner control system is supplied by Webster, the wiring diagram will show the control system wiring to the burner control servos, burner limits and fuel trains. If Webster does not supply the burner control system, the wiring diagram will show burner mounted components wired back to a burner mounted junction box.

7.8 The combustion air fan motor shall be wired per the diagram on the motor. The combustion air fan rotation direction must be verified. The standard direction of rotation is clockwise, viewed from the motor side.

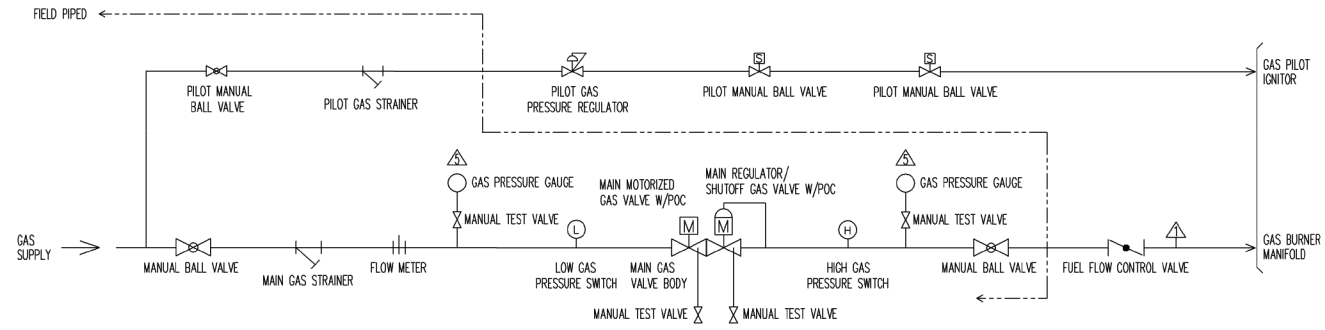
7.8.1 The fan is balanced at the factory. Shipment, installation, and any number of factors may cause the fan wheel to fall out of balance. Prior to equipment startup, verify the fan operates vibration free. The fan should not be operated with excessive vibration as it may damage the equipment or be a safety issue.

7.9 The opening between the vessel breeching and the HDRA-RF burner should be reduced to a 1” gap to limit the tramp air drawn in by the exhaust fan. The HDRA is a total air burner and does not require air beyond what the combustion air fan provides. Do not weld closed or completely seal the gap between the breeching and the burner as the breeching will move due to thermal expansion/contraction and vibration.

8. NATURAL GAS FUEL PIPING SYSTEM

The natural gas fuel piping system is designed to meet NFPA guidelines. The system contains the safety shut-off valves, manual shut-off valves, pressure switches and other components that may be required for the specific installation, available gas pressure, insurance codes and local regulations. natural gas fuel piping systems tend to be designed for each application and a unit specific assembly drawing is provided for each unit, identifying the major components. Details are provided in the burner manual included with each burner.

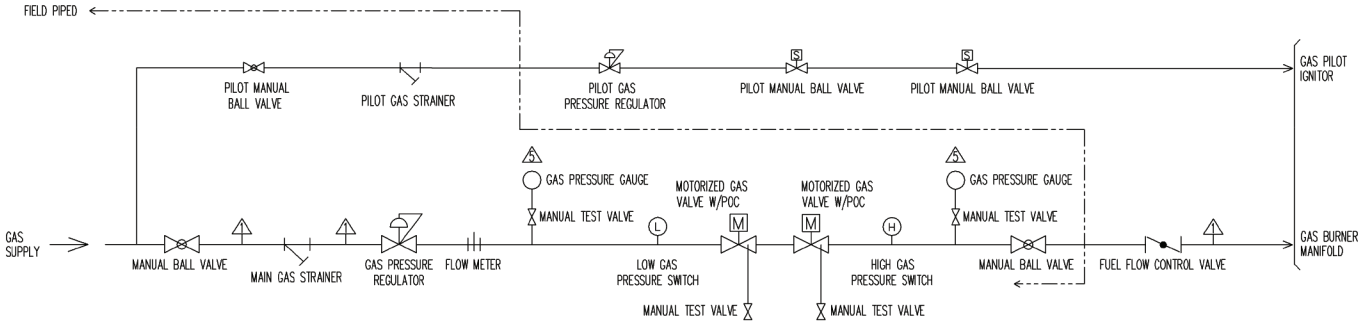
722200



NOTES & OPTIONS

1. TEST CONNECTION
2. REFER TO BILL OF MATERIAL FOR PART NUMBERS OF ABOVE ITEMS.
3. FOR WIRING OF GAS VALVES, MAIN GAS VALVE IS LOCATED CLOSEST TO BURNER HEAD, SAFETY GAS VALVE IS LOCATED FARTHEST FROM BURNER HEAD.
4. VALVE BODY AND VALVE ACTUATOR MUST BE ASSEMBLED. MATCH POC VALVE WITH POC ACTUATOR.
5. GAUGE MAY BE MOUNTED, OR SHIP LOOSE.

722201



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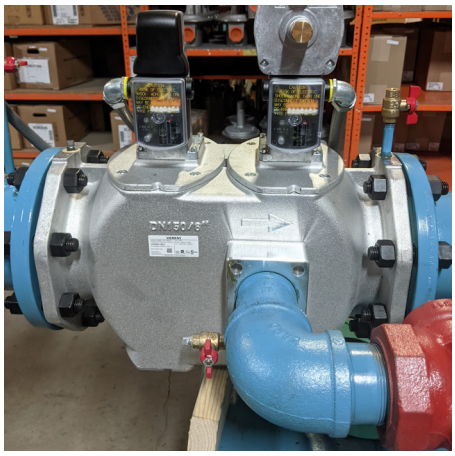
5. GAUGE MAY BE MOUNTED, OR SHIP LOOSE.

The gas train shown in 722201 uses a gas pressure regulator upstream of two safety shutoff valves. The gas train shown in 722200 uses a gas pressure regulator built into the second safety shutoff valve.

Depending on how the burner was ordered, the natural gas fuel piping system may be shipped as loose components for field installation, pre-piped and wired for installation onto a fuel rack, or pre-installed on a fuel rack for field placement. The natural gas fuel piping system components must be installed horizontally for proper operation.

8.1 Gas Safety Shut-Off Valve

Each gas train has two shutoff valves. The shutoff valves are either motorized or pneumatic to open and spring return to close. They contain a proof of closure switch to prove that the valve is in the closed position prior to starting the burner. The fuel shutoff valves open during burner light-off and close to shutoff the burner.



Typical Double Block Gas Safety Shut-Off Valve

8.2 High Gas Pressure Switch

The high gas pressure switch is located after the last shutoff valve and before the gas flow control valve. It is set at a pressure 10% greater than the highest gas pressure expected at this location. If the gas pressure rises above this setting, the switch will trip and cause the burner to shut down. See section 15.4.Q for further instructions.

8.3 Low Gas Pressure Switch

The low gas pressure switch is located before the first shutoff valve and downstream the main gas pressure regulator. It is set at a pressure 10% less than the expected gas pressure at this location. If the gas pressure falls below this setting, the switch will trip and cause the burner to shut down. See section 15.4.P for further instructions.

8.4 Gas Pressure Regulator

Each gas train must have a gas pressure regulator. The regulator insures a consistent supply pressure to the burner. The gas pressure regulator is installed upstream the first gas safety shutoff valve, or it can be integrated into the second shutoff valve.

8.5 Gas Control Valve

The gas control valve is used to modulate the flow of gas fuel to the burner. The burner control system (such as the ABMS) modulates the gas control valve in response to required burner load with an electronic signal sent to an actuator connected to the gas control valve. The gas control valve is located just upstream from the gas connection into the burner.

8.6 Gas Strainer

A gas strainer is installed to catch particulate that may be in the gas, preventing the particulate from fouling the gas train components and burner internals or affecting combustion performance.

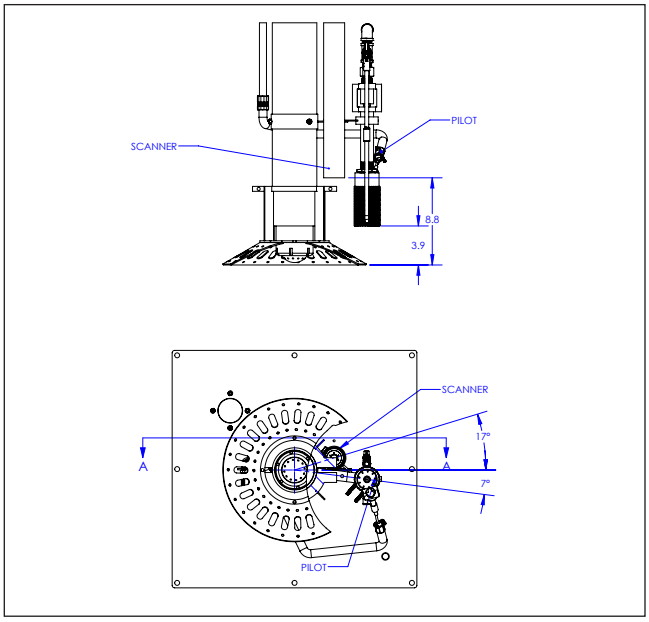
8.7 Flow Meter

The gas flow meter is used to measure the quantity of gas entering the burner. The gas flow meter is usually used to set up and commission the burner. **See Appendix 1 on pages 32-36.**

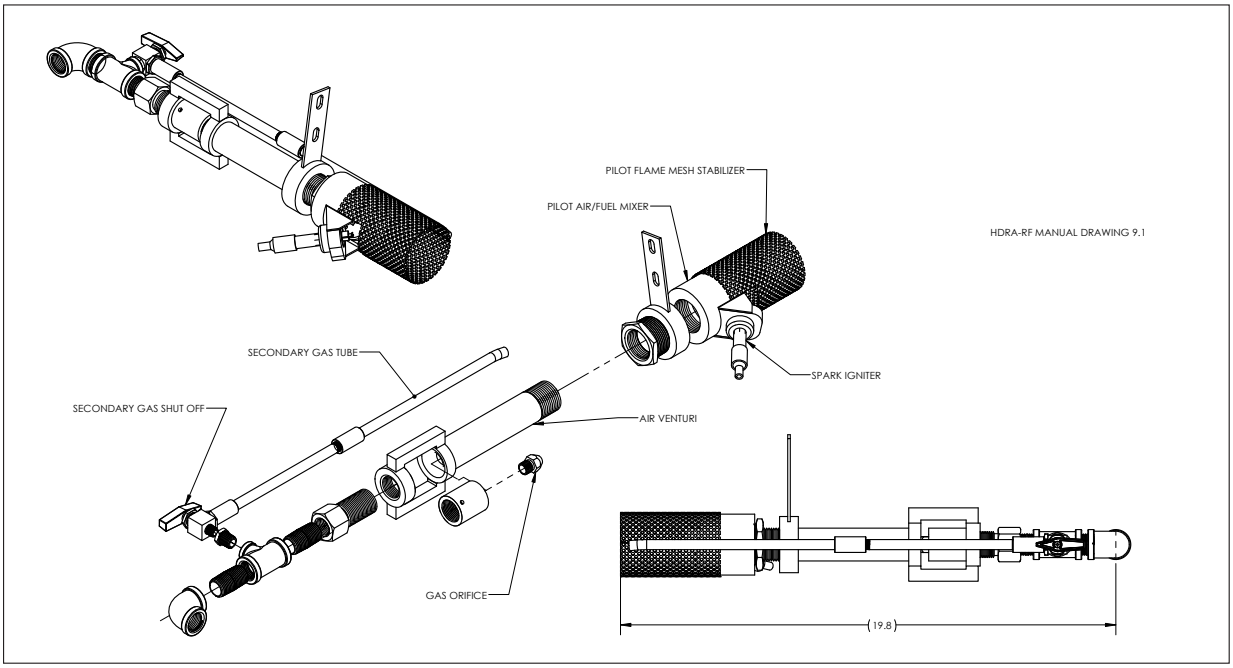
9. BURNER PILOT SYSTEM

The pilot assembly is located in the burner head, behind the main gas orifices. A bracket mounted to the main gas tube is used to hold the pilot end in the correct position. The pilot assembly is fed gas by a gas tube the runs adjacent to the main gas tube. The pilot should be located as shown below.

The gas orifice creates a high velocity jet of fuel that creates suction as it passes into the pilot venturi, drawing in air. The mixture of fuel and air is ignited by the spark igniter, which creates a small flame. The secondary gas Tube boosts the strength of the pilot to create a large, bushy flame. The secondary gas tube is equipped with an isolation valve, but typically this valve should be left open at all times.



Drawing 9.1 The igniter cable and gas connection enter through the rear of the burner. See drawing 11.1 for further detail. Pilot train details are included in Section 8.



Drawing 9.2 The scanner is located behind the main burner diffuser and adjacent to the flame scanner. The flame scanner is positioned to easily detect the pilot flame.

10. OIL TRAIN

The HDRA-RF burner uses air assisted oil atomization to fire fuel oil. The atomizing air is supplied by either a plant air system or a dedicated air compressor.

10.1 Oil Pump

An oil pump is used to supply the oil to the nozzle at sufficient flow and pressure for the nozzle. The oil pump is provided as a separate item that must be mounted, wired and plumbed. The assembly consists of the pump, motor, coupling, pump-motor bracket and oil pressure regulator. The motor base mount is used to secure the assembly. The back pressure regulator must be adjusted to the required pressure for the burner system, typically approximately 100 psig.

10.2 Oil Train

The oil train meets NFPA 86 guidelines. The oil train contains the safety shut-off valves, pressure switches and other components that may be required for the specific installation, insurance codes and local regulations and can vary from burner to burner. Oil trains tend to be designed for each application and a unit specific oil train drawing is provided with each unit. Details of the actual components are provided with each burner.

For efficiency and emissions, the oil must be 90SSU or less.

Typical Air Atomized Oil Train

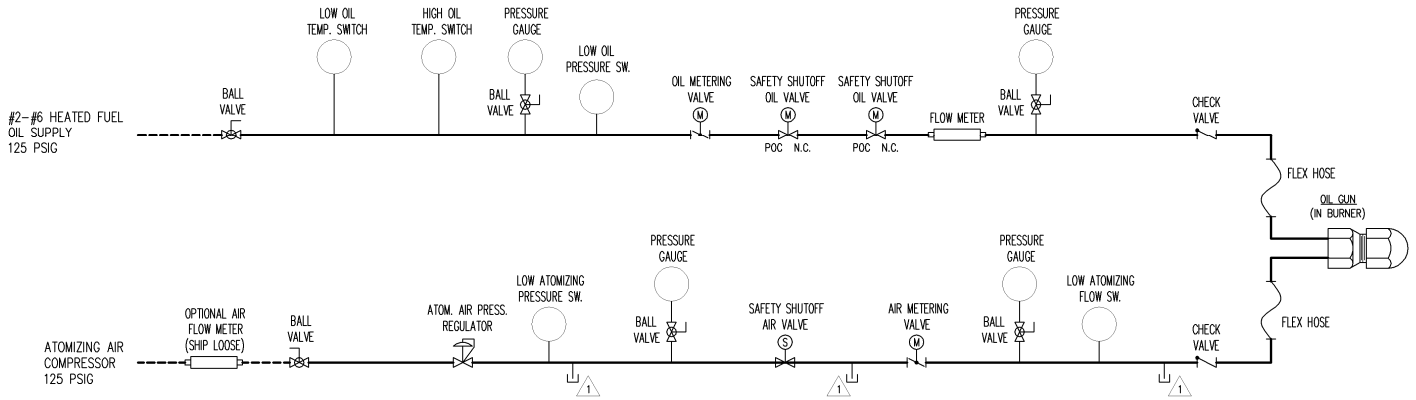


Table 10.2 – Standard Fuel Oil & Atomizing Air Train Piping Sizes

Burner Model	Capacity	Fuel Oil Train Size	Atomizing Air Train Size
	MMBTU/hr	in.	in.
HDRA-RF*-50	50	3/4"	1"
HDRA-RF*-75	75	1"	1-1/4"
HDRA-RF*-100	100	1"	1-1/4"
HDRA-RF*-125	125	1"	1-1/2"
HDRA-RF*-150	150	1"	1-1/2"
HDRA-RF*-175	175	1-1/4"	2"
HDRA-RF*-200	200	1-1/4"	2"

10.3 Oil Safety Shutoff Valve

Each oil train has two automatic shutoff valves. The valves are typically the motorized type and have a POC (proof of closure) switch.

10.4 Low Oil Pressure Switch

This switch is set to 10% below the lowest expected oil pressure and will trip if the oil pressure drops below this level, shutting down the burner.

10.5 Low Oil Temperature Switch

For high viscosity oils like #6 fuel oil or RFO, the oil is too viscous for proper atomization, resulting in high Carbon Monoxide emissions and soot. The oil must be heated to maintain the oil viscosity above 90 SSU (Saybolt Seconds Universal). The temperature at which the oil viscosity falls below 90 SSU varies on fuel quality. The low oil temperature switch is set to a temperature below which the oil viscosity will rise above 90 SSU, typically around 150 – 175 degrees Fahrenheit. If the oil temperature falls below the temperature switch setpoint, the burner will shut down.

10.6 High Oil Temperature Switch

Like the low oil temperature switch, the high oil temperature switch is used with high viscosity fuels. At elevated temperatures, the fuel oil liquid will turn to a fuel vapor, which results in poor combustion and can damage components like valves or pressure gauges. The high temperature switch is set to a temperature above which the oil will turn to vapor, typically around 220 – 260 degrees Fahrenheit. The temperature depends on the fuel quality. If the oil temperature rises above the temperature switch setpoint, the burner will shut down.

10.7 Oil Flow Metering Valve

The oil flow metering valve is used to modulate the flow of fuel oil to the burner. The burner control system (such as the ABMS) modulates the oil metering valve in response to required burner load with an electronic signal sent to an actuator connected to the oil metering valve. The oil metering valve is located just upstream from the oil connection to the burner oil gun.

10.8 Flexible Connections

Webster recommends using a flexible connection to connect the oil line and atomizing air lines to the burner. A flexible connection will reduce vibration stress on the oil gun and simplify installation and maintenance. The oil gun position may need to be adjusted for the purposes of combustion performance.

10.9 Oil Flow Meter

The oil flow meter is included in the fuel train piping. It is primarily used for tuning purposes to verify oil flow rate. Refer to the separate manual on the oil flow meter for directions on operation and maintenance.

10.10 Air Compressor

The air compressor provides air to the oil nozzle to atomize the oil. The compressor assembly includes the compressor motor, relief valve and flexible connection to isolate the vibration of the air compressor.

Compressed air consumption is tabulated in Section 3.

10.11 Safety Shut Off Air Valve

The atomizing air train is equipped with a single automatic air shut off valve. Redundancy is not required as compressed air is not combustible.

10.12 Atomizing Air Pressure Regulator

The atomizing air pressure regulator protects the burner from changes in air pressure. A change in air pressure will affect the oil flow to the burner and reduce atomization efficiency.

10.13 Low Atomizing Pressure Switch & Low Atomizing Flow Switch

The low atomizing pressure switch is located upstream the Safety Shut Off Air Valve, and it is used to prove the presence of compressed air prior to burner light-off. The low atomizing flow switch is located downstream of the air metering valve and any other means of isolating the compressed air from the burner. It is used to prove the continued presence of atomizing air while the burner is in operation.

10.14 Air Flow Meter

The air flow meter is an optional device used to monitor compressed air consumption. It is not required for burner operation.

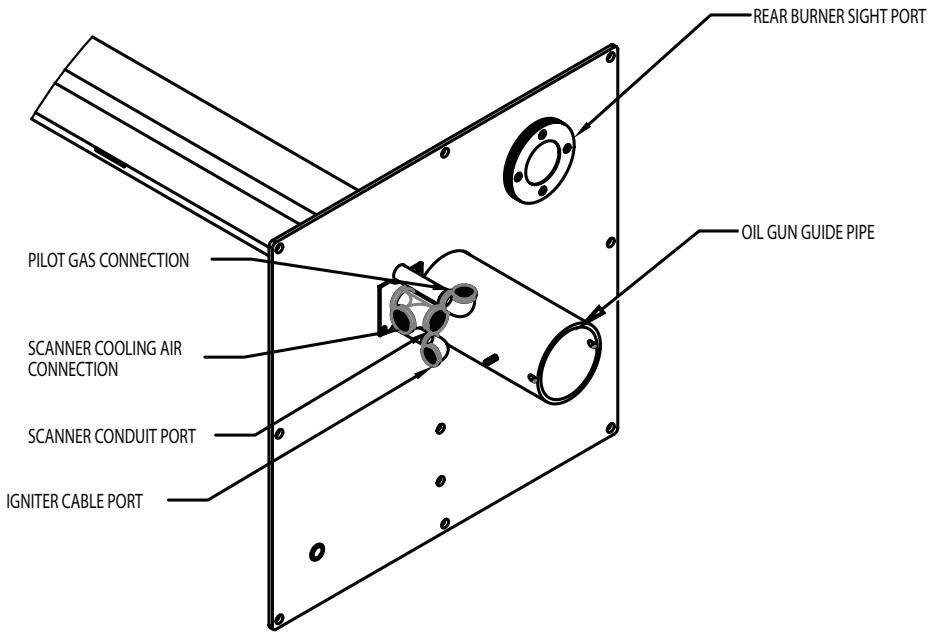
10.15 Air Metering Valve

The air metering valve is used to modulate the atomizing air pressure to the burner. The burner control system (such as the ABMS) modulates the air metering valve in response to required burner load with an electronic signal

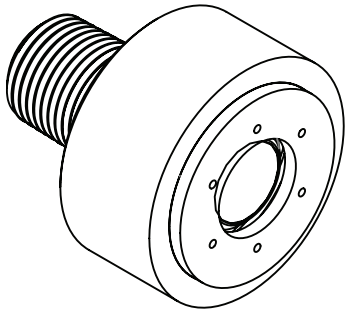
11. FLAME SCANNER

The flame scanner is located adjacent to the pilot and behind the main burner diffuser. The flame scanner is inside a tube attached to the rear of the burner. The scanner is located at the far end of the tube, closest to the flame. Conduit runs the length of the tube; the scanner may be retracted out the back of the burner by pulling on the conduit, or it may be removed from the combustion zone. A fitting (Drawing 11.2) mounted to the scanner tube is used to guide the scanner within the tube and hold the scanner in the correct position. See drawing 9.2.

The flame scanner conduit connects to a tee fitting at the back of the burner. The unused leg of the tee is for cooling air if the scanner is prone to overheating. If it is not required, the leg may be plugged. The tee fitting is removable such that the conduit and scanner can be drawn out. See drawing 11.1.



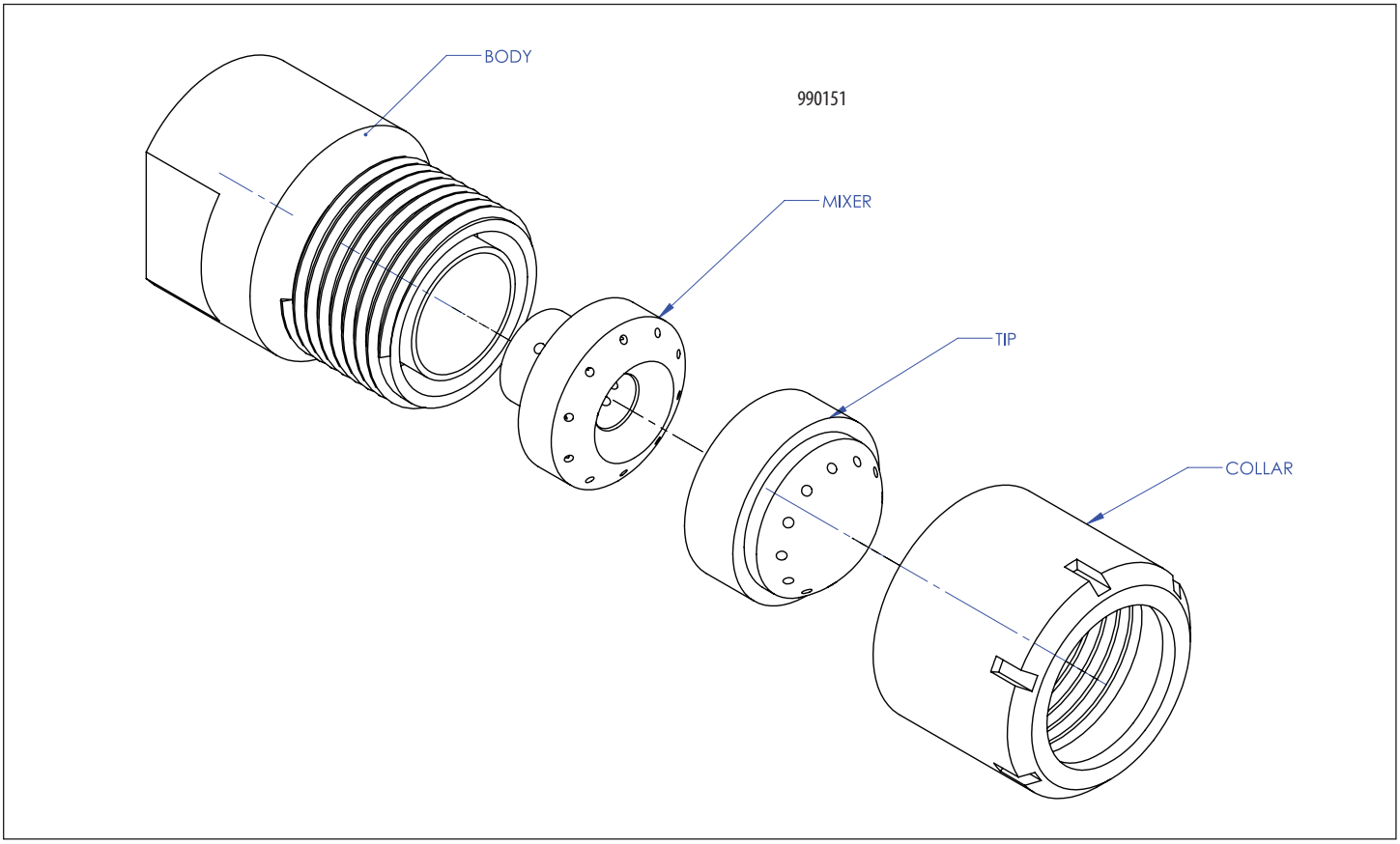
Drawing 11.1 Burner rear access cover



Drawing 11.2 Fitting to Hold Scanner within Scanner Tube

12. FUEL OIL NOZZLE

The oil nozzle is a four-component assembly consisting of a body, collar, mixer, and tip. See below diagram from a 100 MMBTU/hr oil nozzle.



The table below lists the oil nozzle parts by size.

	Part Number						
	Assembly	**Gasket**	**Body**	**Collar**	**Mixer**	**Tip**	**Wrench**
HDRA-RF*-50	270238	101474	270239	150456	270241	270240	990157
HDRA-RF*-75	275185	101474	270239	150456	275188	275189	990157
HDRA-RF*-100	275139	100123	275124	275127	275137	275138	990151
HDRA-RF*-125	275132	100123	275124	275127	275131	275130	990151
HDRA-RF*-150	275156	100123	275147	275127	275146	275145	990151
HDRA-RF*-175	275186	100123	275147	275127	275149	275148	990151
HDRA-RF*-200	275187	100123	275147	275127	275151	275150	990151

13. RECOMMENDED SPARE PARTS

Part numbers vary with the scope of supply of the burner and the specific requirements of the project. Refer to the Bill of Materials (BOM) that is included with every burner order for the correct part numbers.

Parts denoted as “Per Order” indicate that the BOM is to be consulted for the correct part number.

Parts listed with part numbers are standard parts, but they may have changed due to project requirements and the BOM should be consulted.

Item	Quantity	Part Number	Description	Note
General Burner Components				
1	1	770232	NEMA 4 Air Flow Switch, 0.16"w.c. - 1.2"w.c.	For burners with VFD control, without an air inlet louver
2	1	770234	NEMA 4 Air Flow Switch, 2"w.c. - 20"w.c.	For burners with or without VFD control, with an air inlet louver
3	1	480159	Louver Box & Fuel Valve Position Limit Switch	
4	1	160252	Louver Box & Fuel Valve Position Limit Switch Arm	
5	1	777052	High Torque Servo, Standard Model	For use on register and louver boxes
6	1	777048	Low Torque Servo, Standard Model	For use on fuel control valves and atomizing air valves.
7	1	772173	Standard 6 Amp Fuse	For Standard Low & High Torque Servos
8	1	Q624A1014	Ignition Transformer	
9	1	101474	Oil Nozzle Gasket, 50 & 75 MMBH Burners	
10	1	100123	Oil Nozzle Gasket, 100 - 200 MMBH Burners	
11	1	793011	Standard UV Flame Scanner	
12	1	220069	Spark Igniter	
13	1	55231	Spark Igniter Boot	
14	1	Per Order	Combustion Air Fan Wheel	
15	1	Per Order	Combustion Air Fan Motor	
General Train Components				
16	1	Per Order	Gas Shut-Off Valve Actuator	Non-Regulating Type
17	1	Per Order	Gas Shut-Off Valve Actuator	Regulating Type
18	1	Per Order	Gas Shut-Off Valve Body	
19	1	770189	Low & High Gas Pressure Switch	
20	1	324012	Upsteram Pressure Gauge	
21	1	324159	Downstream Pressure Gauge	
22	1	321001	Gauge Cock	
23	1	Per Order	Gas Flow Control Valve	Gas Flow Control Valve

Item	Quantity	Part Number	Description	Note
Gas Pilot Components				
24	1	335059	Pilot Gas Pressure Regulator	
25	1	336095	Pilot Gas Pressure Regulator	Required with new Pilot Gas Regulator
26	2	330027	Pilot Gas Shut-Off Valve	
Fuel Oil & Compressed Air Train Components				
27	1	T428T05030	Low Oil Temperature Switch	
28	1	T429T05030	High Oil Temperature Switch	
29	2	275203	Oil Temperature Switch Thermowell	
30	2	770057	Oil and Atomizing Air Pressure Switch	
31	2	Per Order	Oil Automatic Shut-Off Valve	
32	2	324136	Oil and Atomizing Air Pressure Gauge	
33	1	321001	Gauge Cock	
34	1	Per Order	Oil Flow Metering Valve	
35	1	Per Order	Oil Back Pressure Regulator	Often Supplied with Fuel Oil Pumpset
36	1	Per Order	Atomizing Air Automatic Shut-Off Valve	
37	1	Per Order	Atomizing Air Pressure Regulator	
Oil Pumpsets				
39	1	Per Order	Fuel Oil Pump	
40	1	Per Order	Fuel Oil Pump Motor	
41	1	Per Order	Oil Back Pressure Regulator	
42	1	324140	Oil Pump Inlet Pressure Gauge	

14. INITIAL BURNER SETUP

Attention: Start-up of this equipment should only be done by a qualified person with industrial combustion experience. Start-up by an unqualified person may result in fire, explosion, personal injury or death.

The information and settings are for initial start-up. Final settings will be based on tuning the burner to the plant operating conditions.

1. Visual Inspection

The shipment and installation of the burner can result in loose connections, bent arms and other changes. The burner should be visually inspected for any unusual conditions before operating.

- All wiring connections are tight. Test pulls on wire show them to be tight.
- All fuel lines are tight.
- Burner is mounted to vessel and mounting platform, with all bolts secured.
- Valve actuators are aligned and have not been bent during installation.
- The air damper, register and control valves are tight.

2. Burner Head Checkout

From the combustion zone, inspect the burner head, gas orifices, diffuser, and oil nozzle to ensure all components are secure and in their proper position. Some components can be adjusted to improve combustion and can operate through a range of positions. Other components, like the pilot, must be in their identified position to work properly.

The burner head and register must be inspected to ensure that the components have not shifted or come loose during transit.

3. Motor Rotation

The combustion air fan and pump motors must be checked for proper rotation.

The combustion air fan rotation is marked with an arrow on the fan housing. The rotation can be observed within the motor to verify correct rotation, or if this is not accessible, the burner drawer can be removed to directly observe the fan.

The oil pump has a slot between the motor and pump where the rotation can be observed. An arrow on the pump shows the correct rotation. The direct drive air compressor can rotate in either direction, but belt driven compressor must rotate as the arrow indicates.

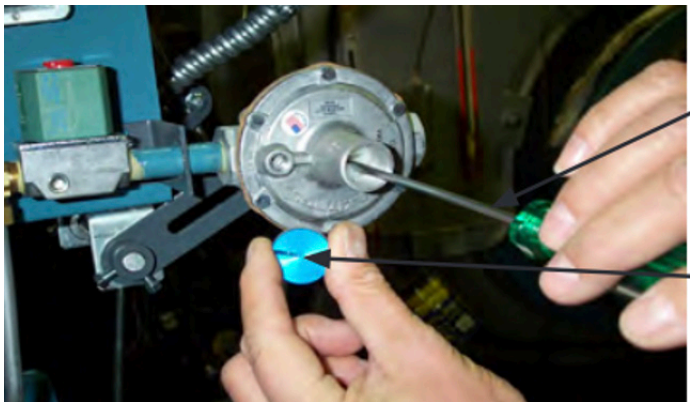
4. Fuel and Atomizing Air Control Valves, Air Louver & Register

The initial positions of the fuel (gas and oil) valves, atomizing air valve, air louver and register are set to be closed or nearly closed at the factory. The position of the control element (valve, register or louver) must be verified to correlate with the actuator servo position – open to open, closed to closed.

5. Pilot & Scanner Setup

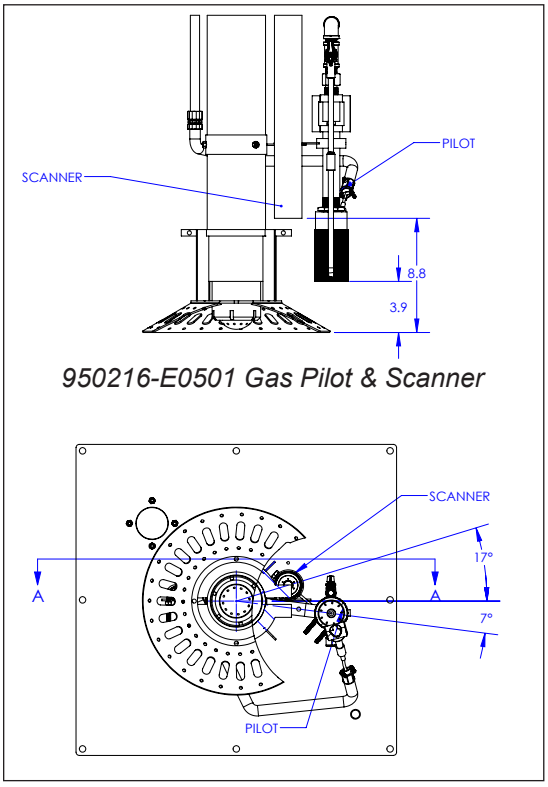
The pilot assembly is located in the burner head, behind the main gas orifices. A bracket mounted to the main gas tube is used to hold the pilot end in the correct position. The pilot assembly is fed gas by a gas tube the runs adjacent toe the main gas tube. The pilot should be located as shown in below.

The gas pilot regulator should be adjusted for a gas.



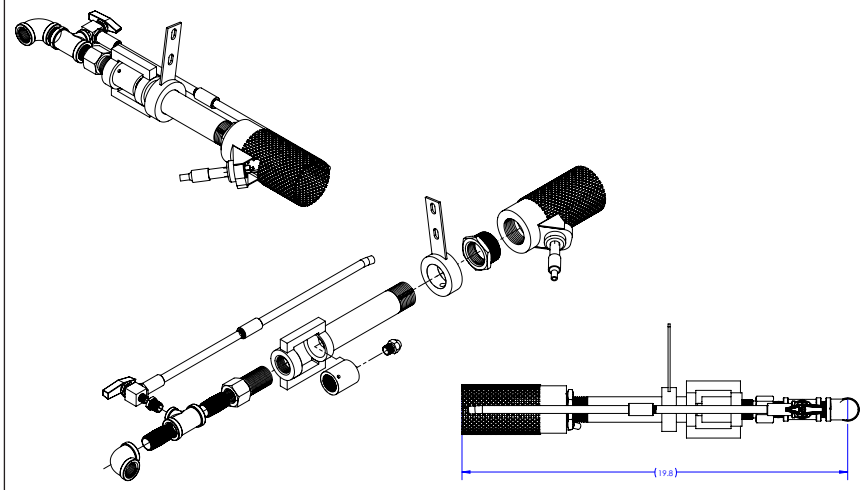
Removable cover *Use screwdriver to adjust regulator*

The scanner is inside to a tube that is inserted through the burner drawer back plate. The scanner is located at the far end of the tube, closest to the flame. Conduit runs the length of the tube; the scanner may be retracted out the back of the burner by pulling on the conduit, or it may be removed from the combustion zone. A bracket mounted to the main gas tube is used to hold the scanner in the correct position.



950216-E0501 Gas Pilot & Scanner

950216-E0502 Component Dimensions of the Pilot



6. Gas System Adjustments

The gas pressure regulator should be set to the required gas pressure. If this value is not known, a value of approximately 50% over the high fire gas manifold pressure (given on burner nameplate) can be used for the initial setting. It will be adjusted at startup to obtain the rated capacity during setup.

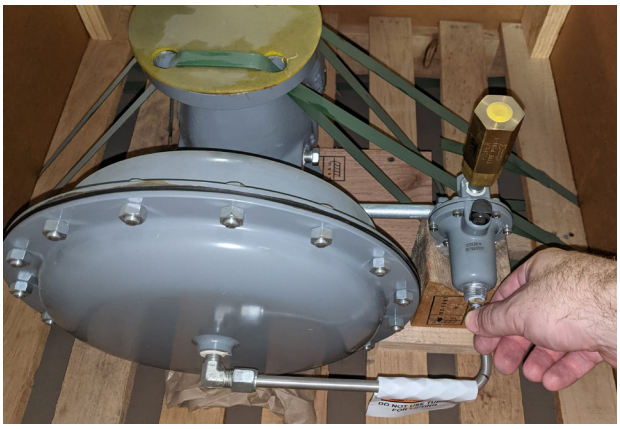
The low gas pressure switch should be set for an initial value of 50% below the lowest expected gas pressure. The high gas pressure switch should be initially set at 50% above the highest valve expected at that point.

Removable cap

Use screwdriver to adjust regulator

Main gas regulator adjustment – Self-actuated regulator

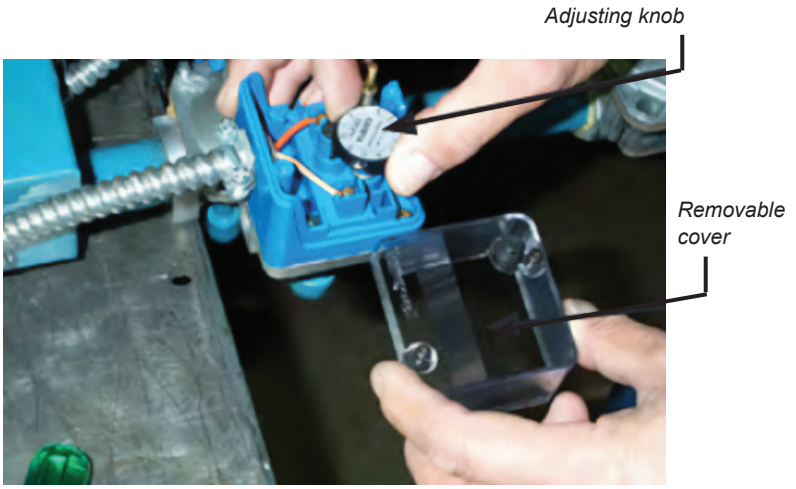
Pilot-actuated regulator



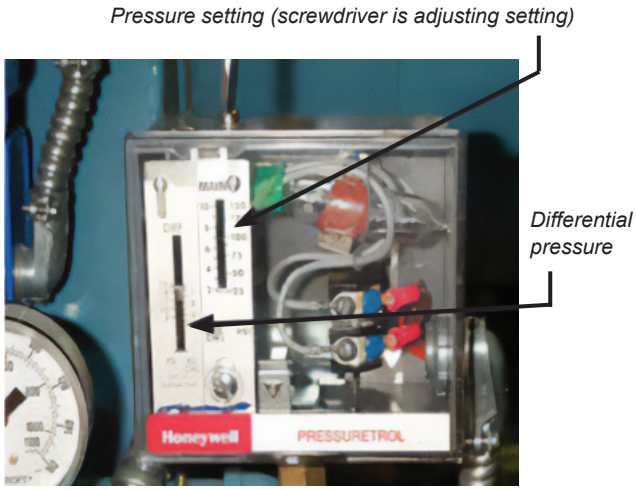
Main diaphragm

Pilot regulator adjustment screw

Main gas regulator adjustment – Pilot-actuated regulator



Gas pressure switch adjustment – Type A



Oil pressure switch adjustment

Gas or Oil pressure switch adjustment – Type B

7. Oil System Adjustments

The oil pressure supply to the burner should be set for 125 psig. The oil pressure regulator is adjusted by removing the cap and turning the regulator screw clockwise (cw) to increase pressure and counterclockwise (ccw) to decrease pressure.

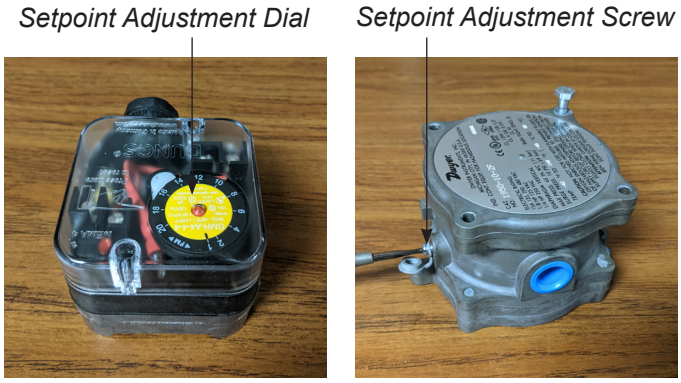
The low oil pressure switch should be set for a pressure of about 25 PSIG lower than the regulated pressure.

8. Air Proving Switch

The air proving switch as not been setup at the factory; it must be setup during commissioning once low fire has been established.

If the burner fan is connected to a VFD, bring the fan speed (VFD) and air louver setting (if present) to the minimum firing rate setting. Adjust the switch setpoint until the switch opens, then turn the adjustment screw counterclockwise one turn to adjust the pressure setting.

If the burner fan is not connected to a VFD, tun the fan on and bring the air louver to the purge position. Adjust the switch setpoint until the switch opens, then turn the adjustment screw counterclockwise one turn to adjust the pressure setting.



Air proving pressure switch adjustment

15. STARTUP AND OPERATING ADJUSTMENTS

This section covers the startup and operating adjustments of the burner.

WARNING: BURNER STARTUP, COMBUSTION ADJUSTMENTS AND LIMIT CONTROLS ADJUSTMENTS SHOULD ONLY BE PERFORMED BY TRAINED AND EXPERIENCED SERVICE TECHNICIANS. ATTEMPTING TO PERFORM THESE FUNCTIONS WITHOUT THE PROPER TRAINING AND EXPERIENCE CAN RESULT IN EQUIPMENT DAMAGE, PERSONAL INJURY OR DEATH.

Before proceeding with the startup and adjustment, be sure that the overall installation is complete. Review the operating and installation manual for the vessel, as well as all control manuals to verify that all equipment is ready for operation. These manuals must be read and understood prior to starting the equipment.

If you are not qualified to service this equipment, **DO NOT TAMPER WITH THE UNIT OR CONTROLS – CALL YOUR SERVICEMAN.**

At the conclusion of the startup, document valve positions, pressures and settings for future reference.

READ AND SAVE THESE INSTRUCTIONS FOR FUTURE REFERENCE.

1. Pre-Start Check List

Before starting the burner, a complete review of the installation, wiring and piping of the burner, boiler and all supporting equipment must be complete, and all these items must be ready for operation prior to starting. The following is a general review:

_____All wiring is connected. Test pulls on wire show them to be tight.

_____All fuel lines are connected and tight.

_____Pilot gas is connected.

_____Burner is mounted to vessel and floor, with all bolts secured.

_____The stack is connected. Plant draft controls are installed and operational.

_____Do not start the unit unless all cleanout doors are in place and secured.

_____The vessel is completely installed, ready to be fired and operating controls checked.

_____Support equipment is in place and ready

_____A load must be available for the burner startup and adjustment process. The burner must be operated at high rates for extended periods of time and the load must be capable of using this energy.

_____A combustion analyzer with O_2 and CO must be available to tune combustion. Analyzers must be recently calibrated and able to provide accurate readings.

_____Other test equipment, including manometers, gauges and voltmeter shall be available.

_____Manometer or gauge on the gas manifold

_____Manometer or gauge before and after gas pressure regulator

_____Draft gauge or manometer for combustion zone pressure

2. Gas Setup

a. Place the burner switch in the “OFF” position.

b. Place the “Auto-Manual” switch in the manual position. If the burner is combination fuel and oil, make sure the fuel selector switch is on “GAS”.

c. Place the fire rate control in the minimum (low fire) position.

d. Close the downstream manual shutoff valve (closest to the modulating valve) on the gas train.

e. Turn the electrical power on for the burner and related components.

f. Verify the gas metering valve is nearly closed and verify the gas pilot valves are not open (the solenoid will hum and feel warm).

g. Start the draft fan and combustion air fan.

h. Turn the burner switch on to initiate the pre-purge cycle.

i. When the pre-purge sequence is complete and the low fire start switches are made, the pilot valves will open, and the pilot flame should be visible through the burner sight port.

j. When the pilot flame is established, the flame safe-guard will energize the main gas valve (indicated with the Fuel Valve Light). This operation of the main fuel valves should be visually checked.

k. After the timer has completed the trial for main flame, the burner will go out on alarm (the closed manual gas valve prevented the burner from lighting). At this time, the gas valves must be visually checked to verify that they have closed. This test sequence proves the proper operation of the primary control.

l. Press the reset button and restart the burner. When the pilot has started, open the manual gas valve to allow the main flame to start.

m. After a few seconds, the combustion analyzer should have an accurate reading of the O_2 in the stack. Verify the O_2 and CO are within the expected limits, and that the combustion is stable: no unexpected vibration, rumble or noise. Rough settings for low and mid-fire combustion settings are adequate at this time. Once the high fire is set, other settings can be fine-tuned.

n. Adjust the high fire input to match gas manifold pressure to the maximum input listed on the rating label.

NOTE: The listed manifold pressure is only an approximate value and can vary with operating conditions and normal tolerances. The fuel flow rate should be measured to obtain an accurate input value. At high fire, the gas butterfly valve should be at least 50 degrees open (more if available gas pressure is low), and the gas pressure regulator adjusted to obtain the rating. The input should be measured using the following equation:

Rate=HHV×(P_Atm+P_gas)/29.92×520/(T_gas+460)×Q_gas

Where:

i. HHV – heat content of the gas, measured in BTU/SCF

ii. P.atm – Atmospheric pressure in Inches of Mercury (“Hg)

iii. P.gas – Gauge pressure (measured with a manometer or gauge) of the gas in Inches of Mercury (“Hg)

iv. T.gas – Gas temperature in degrees Fahrenheit

v. Q.gas – Gas flow rate measured from the flow meter in ACFH (Actual Cubic Feet per Hour)

o. Run the burner through the operating curve, verifying performance through the range. Adjust the fuel, air, and register as required.

p. Adjust the low gas pressure switch to be 10% below the lowest expected gas pressure.

i. With a gauge or manometer at the same location as the low gas pressure switch, modulate the burner to determine the firing rate with the lowest gas pressure.

ii. At the lowest gas pressure, adjust the low gas pressure setting up until the switch breaks and causes the burner to shutdown.

iii. From the scale reading of the switch, adjust the setting to a pressure that is 10% lower than the shutdown pressure. For example, if the switch opened at 10 inches as indicated on the low gas pressure switch, the switch should be adjusted to a reading of 9 inches.

iv. Remove the gauge or manometer and plug the opening.

v. Cycle the burner on and off to determine if the limit works properly.

vi. If the limit causes nuisance shutdowns because of small pressure drops during startup, reduce the pressure setting an additional 5%.

q. Adjust the high gas pressure switch to be 10% above the highest expected gas pressure.

i. With a gauge or manometer at the same location as the high gas pressure switch, modulate the burner to determine the firing rate with the highest gas pressure.

ii. At the highest gas pressure, adjust the high gas pressure setting down until the switch opens and causes the burner to shutdown.

iii. From the scale reading of the switch, adjust the setting to a pressure that is 10% higher than the shutdown pressure. For example, if the switch opened at 10 inches as indicated on the high gas pressure switch, the switch should be adjusted to a reading of 11 inches.

iv. Remove the gauge or manometer and plug the opening.

v. Cycle the burner on and off to determine if the limit works properly.

vi. If the limit causes nuisance shutdowns because of small pressure changes during startup, increase the pressure setting an additional 5%.

r. The burner should be operating at low fire to adjust the air proving switch. Turn the adjusting screw clockwise (in) until the burner trips out (shutdown caused by the air flow switch). Turn the adjustment screw counter clockwise (out) 1 1/2 turns from the point of shutdown. Check the operation at higher rates.

3. Oil Setup

The air atomized oil system has the potential for a large turndown range similar to gas and has the potential to be adjusted to different low fire rates. See the burner name plate for details on actual rates for the burner.

a. Place the burner switch in the “OFF” position.

b. Place the “Auto-Manual” switch in the manual position. If this is a combination fuel burner, make sure the fuel selector switch is on “OIL”.

c. Place the manual flame control potentiometer in the minimum (low fire) position.

d. Close the manual shutoff valve on the oil train.

e. Turn the electrical power on for the burner and related components.

f. Verify that the oil metering valve is at the nearly closed position and verify the gas pilot valves are not open (the solenoid will hum and feel warm).

g. Start the draft fan and combustion air fan.

h. Turn the burner switch on to initiate the pre-purge cycle.

i. When the pre-purge sequence is complete and the low fire start switch is made, the pilot valve will open, and the pilot flame should be visible through the burner sight port.

4. Normal Shutdown

Normal operation of the burner will allow the operating controls to shut the burner down when the load demand is satisfied. If the burner needs to be shut down for any reason, the “ON-OFF” switch can be used to quickly turn the burner off. This will instantly cause the fuel valves to close and start a post purge cycle to remove any unburned fuel from the vessel.

In an emergency shutdown, all fuel and electrical power should be de-energized or turned off to secure the burner. This would include the main power disconnect, the manual gas shutoff, and the manual oil valve to the nozzle.

It is recommended that the burner be manually driven to low fire before turning the burner off, as this reduces the dynamic and thermal stress. If the burner will remain off for some time, the manual fuel valves, fuel pumps and power supply should be turned off.

CAUTION: ALWAYS KEEP THE FUEL SUPPLY VALVE SHUT OFF WHEN THE BURNER IS SHUT DOWN FOR AN EXTENDED PERIOD OF TIME.

5. Restarting after Extended Shutdown

Extended shutdowns require the same startup process as those outlined above. In addition, the following advanced cleaning must be done:

a. The oil nozzle should be removed and cleaned. Use care in cleaning to preserve the sharp edges of the nozzle, which are required to maintain good atomization.

b. The oil filter and strainer and gas strainer must be removed and cleaned prior to starting.

CAUTION: DO NOT START THE BURNER UNLESS ALL CLEANOUT DOORS ARE SECURED IN PLACE.

16. MAINTENANCE

1. General

This burner has been designed to provide many years of trouble-free operation. The reliability can be greatly improved with some simple inspection and maintenance programs.

One of the best tools for a good maintenance program is to keep a log on the key parameters of the burner and boiler. These would include operating temperatures, pressures, inspections and preventative maintenance activities. This document can be used to detect any changes in the operating characteristics of the burner, which can be used for preventative maintenance.

The maintenance schedule can be used to help generate this log. There are also many other good references that can be used to help develop your log. Adding check points for other equipment into a common log can help. It is common to integrate the burner log into the facility wide log, so that all components are checked at the same time.

The frequency of inspection given in the following charts is only a guideline. Initial results should be used to adjust the time intervals to be more frequent when problems or potential problems are observed.

2. Physical Inspection

Listening and looking at the burner can detect many problems. For example, leakage can usually be seen early with a small buildup of oil . Valve and linkage problems can usually be detected early on by simply watching the movement and detecting rough or uneven changes. The jackshaft, linkage and valve movement should occur smoothly with no rough jerks.

The flame condition can often be a good indicator of the firing head. If the flame does not look correct, there may be a problem with the hardware. The firing head is exposed to the high temperatures of combustion and can have reduced life due to the thermal stress. In particular, the diffuser, oil nozzle, gas spuds, gas manifold, and burner mounting plate should all be inspected.

3. Fuel-Air-Ratio Controls

The fuel-air-ratio controls must be maintained in good operating condition. Over time, these items will wear and may not operate smoothly. Corrective action must be taken. There are several different types of controls and the corrective action of each could be different.

If the burner will be operating for extended periods on gas, the oil gun should be removed to prevent the oil nozzles from “coking” due to the heat of the gas flame.

4. Gas Fuel System

The safety interlocks must be checked at regular intervals to ensure that they provide the proper safety. See the Inspection and Maintenance Schedule Chart for frequencies.

Monitoring the outlet gas pressure from the regulator will verify the regulator is working properly.

5. Oil Fuel System

The oil system has additional components that require regular maintenance, depending on the type of system used.

a. Oil added to air compressor. The air compressor has a visual sight glass showing the oil level. This must be inspected every shift (while operating).

b. Air compressor belt tight and in good condition

c. The oil strainer should be checked and cleaned periodically. A high vacuum reading on the suction side of the pump (over 10”) is a good indication that the strainer needs to be cleaned. Strainers provided by Webster will use a wire mesh basket inside a canister. After turning the pump off (and making sure there is no pressure on the strainer), unscrew the yoke to gain access to the basket. The canister does not need to be drained. Be careful with the gasket when removing or replacing the cover to ensure a good seal. The basket can be lifted out and cleaned with a soft brush and cleaning solution.

d. Vacuum within the 10” limit on suction side of pump (indicates need to clean strainer, as described above). If cleaning the strainer does not resolve this, check the other valves between the tank and gauge for plugged or closed position.

e. Air atomized oil nozzles should be cleaned periodically, depending on the type of operation and the observed need for cleaning. Extended operation at very low rates (less than 15% of capacity) can cause carbon buildup on the outside of the nozzle. This can be cleaned with a rag and cleaning solution. If the fire is showing some deterioration, and the external surfaces are clean, then the nozzles should be removed, disassembled, and cleaned using a soft brush and cleaning solution.

f. If the edges of the air atomizing nozzle are not sharp, or the nozzle shows sign of wear and the combustion is deteriorated, the nozzle should be replaced. The nozzle part number is given on the unit's material list.

g. Check safety limits, including pressure and temperature switches.

6. Combustion Air Fan

If the fan and motor are ever removed, the following should be observed in re-assembly.

a. There should be an overlap of inlet cone and fan. See drawing 950216-C0202.

b. Never re-use the fan to motor shaft set screws, always use new screws of the same size and style to maintain balance and fan retention.

c. When tightening the fan hub set screws, rotate the fan to place the screws on the bottom. This way the screw is not lifting the fan.

d. The motor shaft and fan hub must be clean and free of burrs.

7. Inspection and Maintenance Schedule

Frequency								Performed By	
Daily	Weekly	Monthly	Seasonal	Annual	Annual As Required	Component / Item	Recommended Action or Test	Boiler Operator	Trained Burner Technician
X						Burner Flame	Visual inspection of burner flame.	X	
X						Jackshaft and Linkage	Visual inspection for smooth and free travel.	X	
X						Air Damper	Visual inspection for smooth and free travel.	X	
X						Fuel Metering Valves	Visual inspection for smooth and free travel.	X	
X						Draft Controls (Stack)	Visual inspection for smooth and free travel.	X	
X						Gas Fuel Pressure	Record in log book, compare trends.	X	
X						Oil Pressure	Record in log book, compare trends.	X	
X						Atomizing Air Pressure	Record in log book, compare trends.	X	
X						Pilot	Visually inspect pilot flame, check and record flame signal strength if metered.	X	
	X					Flame SafeGuard - Pilot Test	Close manual fuel valve on pilot during cycle and check for safety shutdown, recording time.	X	
	X					Flame SafeGuard - Main Flame	Close manual fuel valve on pilot during cycle and check for safety shutdown, recording time.	X	
		X				Flame SafeGuard	Check flame safeguard components, including scanner.		X
				X		Flame SafeGuard	Replace flame safeguard components in accordance with manufacturers instructions.		X
		X				Oil Pressure and Temperature Interlocks	Check oil pressure and temperature switch for smooth operation and correct action.		X
		X				Atomizing Air Pressure	Check air atomizing pressure interlock switch for smooth operation and correct action.	X	
		X				Interlock Controls	Check other interlocks that may be used on the burner for smooth operation and correct action.		X
			X			Firing Rate Control	Check firing rate control and verify settings.		X
			X			Combustion Tuning	Conduct a combustion test, verify setting and emission levels.		X
	X					Pilot and Main Fuel Valves	Make visual and manual check for proper sequencing of valves.		X
				X		Pilot and Main Fuel Valves	Check all coils, diaphragms, interlock switch & other parts of all safety shutoff valves.		X
				X		Pilot and Main Fuel Valves	Perform leak tests on all safety shutdown control valves.		X
				X		Low Pressure Air Switch	Test low air pressure switch for proper operation and adjustment.		X
				X		Air Louver Switch	Check damper low fire proving switch per manufacturers instructions.		X
				X		Linkage and Fuel Cams	Check linkage and cams for wear and replace any items with wear indication or stress cracks.		X
					X	Combustion Air Fan	Clean combustion air fan and housing		X
X	X					Burner Components	Visually check the burner components for signs of cracks, deformation, slippage or other unusual indication.		X
		X				Burner Mounting	Check burner mounting clamps and brackets for tightness.	X	
		X				Oil Nozzle	Check and clean oil nozzle.	X	
X						Air Compressor	Check air compressor for lubrication oil and air filter.	X	
				X		Air Compressor	Check air compressor relief valve operation.		X

17. TROUBLESHOOTING

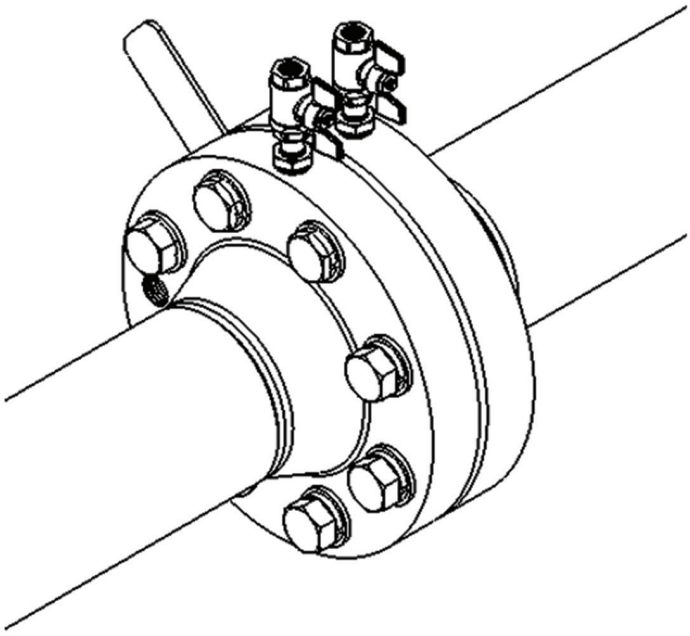
No.	System	Cause	Correction
1	No Ignition	Electrode is grounded. Porcelain is cracked.	Replace
	(lack of spark)	Improperly positioned electrode	Recheck dimensions
		Loose ignition wire connection	Reconnect or tighten
		Defective ignition transformer	Check transformer, replace
2	No Ignition	Lack of fuel, no gas pressure, closed fuel valve	Check fuel supply and valves
	(spark, no flame)	No voltage to pilot solenoid	Check electrical connections
		Defective pilot solenoid valve	Replace
		Incorrect location of pilot	Check location of pilot
		Improper raw gas tube position	Check location of raw gas tube
		Improperly positioned electrodes	Recheck dimensions
		Too much combustion air flow	Check air damper position
3	Pilot not detected	Scanner tube not positioned correctly	Check location of scanner tube
	(flame present)	Scanner tube dirty	Clean scanner tube
		Scanner or amplifier faulty	Replace
		Pilot improperly positioned	Check pilot position
		Incorrect gas pressure to pilot	Readjust pressure
		Combustion air flow rate too high	Readjust damper
4	No main gas flame	Weak scanner signal	Clean scanner lens and tube
	(pilot OK)	Damper or fuel control valve setting incorrect	Readjust
		Fuel valve(s) not opening	Check wiring to valves
5	No main oil flame	Weak scanner signal	Clean scanner lense and tube
	(pilot OK)	Damper or fuel control valve setting incorrect	Readjust
		Fuel valve(s) not opening	Check wiring to valves
		Oil nozzle or line obstructed	Check nozzle and lines, clean
		No atomizing air pressure	Check compressor wiring
		Compressor pressure too low or high	Readjust
		Burner not level, oil is draining into vessel	Check level, adjust as required.
6	Burner stays at low fire	Manual pot in low fire position (low fire hold)	Readjust to high fire position
		Manual-auto switch in wrong position	Change position of switch
		Modulating Control	Check wiring or replace
		Loose linkage	Readjust and tighten
		Binding linkage or valve	Readjust or replace
7	Burner shuts down	Loose electrical connection	Check and tighten connections
	during operation	Loss of fuel supply	Replenish fuel supply
		Limit switch breaks (opens)	Readjust limit switch
8	Burner does not start	Main disconnect switch is open	Close switch
		Loose electrical connection	Check electrical connections
		Operating controls are tripped	Check and reset operating limits
		High or low fuel pressure	Check fuel supply - reset switches
9	High CO at low fire	Improper excess air level	Readjust excess air
	(firing gas)	Input too low for burner components	Check input, compare to rating label

No.	System	Cause	Correction
	High CO at low fire (con't)	High stack draft (especially at low fire)	Stabilize draft
	(firing gas)	Poor air flow distribution (off center flame)	Adjust air straightener blade
		Diffuser not in optimum position	Adjust diffuser position in or out
		Fluxuating gas pressure (regulator not holding pressure)	Check regulator pressure, sensing line and supply pressure: sized properly
10	Gas combustion noise	Input too low for burner components	Check input, compare to rating label
	(rumbling)	Improper excess air	Readjust excess air
		Fluxuating gas pressure (regulator not holding pressure)	Check regulator pressure and supply
		High stack draft (especially at low fire)	Stabilize draft
		Diffuser not in optimum position	Adjust diffuser position in or out
		Poor air flow distribution (off center flame)	Adjust air straightner blade
11	Oil combustion smoking	Oil nozzle dirty or plugged	Clean oil nozzle
		Improper excess air	Readjust excess air
		Input too low for burner components	Check input, compare to rating label
		High stack draft (especially at low fire)	Stabalize draft
		Incorrect nozzle position	Adjust the nozzle to diffuser position
		Fluxuating oil pressures (regulator not holding)	Check regulator pressure and oil supply
		Poor air flow distribution (off center flame)	Adjust air straightner blade
		Too much FGR (if equipped)	Reduce FGR rate
12	Fuel-Air-Ratios are	Linkage flexing	Realign linkage, straighten rods
	not consistent	Linkage slip	Check linkage and tighten all joints
		Fuel cam screws have moved	Replace fuel cam
		Fuel line plugged	Check and clean lines, strainers & filters
		Fuel supply pressure changing	Check and/or replace pressure regulator
		Combustion air temperature changed	Retune burner
		Draft condition changed	Check draft and outlet damper
		Plugged or leaky FGR line	Clean / repair
		Gas control valve - low fire stop not set	Adjust low fire stop
13	Fuel-Air-Ratios have changed	Linkage wear	Check linkage and tighten all joints
	over time	Fuel cam screws have moved	Replace fuel cam
		Air damper seal worn	Replace air damper seals
		Fuel lines plugged	Check and clean lines, strainers & filters
		Fuel control valve worn	Replace fuel control valve
		Gas orifices or gas manifold plugged	Clean and/or replace
		Combustion air temperature changed	Retune burner
		Draft condition changed	Check draft and outlet damper
		Vessel plugged	Clean vessel
		Plugged or leaky FGR valve	Clean / repair
14	Cannot obtain capacity on	Wrong spring range in regulator	Install higher spring range
	gas	Too many elbows before control valve	Rework piping to reduce elbows
		Gas line too small, high pressure drop	Use larger pipe size
		Supply pressure lower then stated	Increase supply pressure
		Supply pressure drops too low at high fire	Use larger gas line sizes / orifice in service regulator
		Regulator too small for flow and pressure	Change regulator
15	Cannot obtain rated input on	Oil nozzles plugged	Replace nozzles
	oil firing (pressure atomized)	By-pass seal on nozzle leaking	Replace nozzles

No.	System	Cause	Correction
	Cannot obtain rated input on	Oil pressure too low	Increase oil pressure
	oil firing (pres. atom.) (con't)	Flow valve set too low (should be closed at high fire)	Adjust oil control valve
		Oil flow valve set too low (should be closed at high fire)	Adjust oil control valve
16	Cannot obtain rated input on	Oil nozzles plugged	Replace nozzles
	oil firing (air atomized)	Air pressure too low	Replace nozzles
		Oil pressure too low	Increase oil pressure
		Flow valve set too low	Adjust oil control valve

NOTES

Versatile Flow Metering Solution For Gaseous Applications



The Differential Pressure Flow Assembly consists of an orifice plate with a pair of flow orifice flanges, tapped for reading differential pressure. Standard materials consist of carbon steel for the flanges and stainless steel for the orifice plate. Because the unit uses pressure difference to measure flow, there are no moving parts that can break during normal operations. Valves included separately upon request.

Select the orifice size in Table 2 based on the application flow requirements. Select the companion orifice flange kit from Table 3.

Installation

The elements may be installed in any configuration. However, the accuracy of the installation is dependent on the flow conditions in the gas train. Longer lengths of straight pipe without features to create an uneven flow profile will result in better accuracy. The minimum upstream and downstream lengths of straight pipe are 10 and 4 diameters, respectively. For improved accuracy, the installation requirements for the elements based upon a uniform velocity profile approaching the flow orifice are shown in Table 1. It is always best to locate the elements as far as possible from all disturbances, with upstream disturbances given the most consideration.

Table 1 – Installation Pipe Lengths

	Upstream Distance in Pipe Diameters	Downstream Distance in Pipe Diameters
Minimum Distance	10	4
Single 90 degree bend	20	4
Single 45 degree bend	18	4
90 deg tee	18	4
Concentric 2D to D Reducer over a length of 1.5 D to 3 D	8	4
Concentric 0.5 D to D Expander over a length of 1.5 D to 3 D	18	4
Ball valve or gate valve completely open	12	4
Thermometer pocket or well	3	4

Maintenance

The sensing elements have no moving parts and only periodic cleaning is required. The sensing elements should be inspected for fouling of the sensing holes as part of an annual preventative maintenance program. Installations carrying viscous fluids or particulate in the fluid may require more frequent inspection.

See drawings 722200 and 722201 under Section 8 for the proper flow meter installation location on HDRA burner gas piping.

Table 2 – Engineering Reference Table

Natural Gas Standard Flow Rates (SCFH) vs Differential Pressure Reading ("w.c.).

			Natural Gas (SCFH)					
Pipe Size	**Part Number**	**Orifice Bore Size**	**0.5" w.c.**	**1.0" w.c.**	**3.0" w.c.**	**5.0" w.c.**	**10.0" w.c.**	**30.0" w.c.**
3"	015715	1.0"	829	1172	2026	2612	3683	6310
3"	015716	1.15"	1103	1559	2695	3475	4899	8394
3"	015717	1.33"	1491	2107	3642	4695	6620	11340
3"	015718	1.55"	2064	2916	5040	6497	9159	15681
3"	015719	1.75"	2698	3810	6584	8485	11959	20461
3"	014561	2.03"	3818	5391	9309	11994	16895	28858
4"	015720	1.65"	2284	3227	5579	7193	10143	17376
4"	015721	1.9"	3070	4338	7499	9668	13631	23345
4"	015722	2.2"	4218	5958	10297	13273	18709	32022
4"	014562	2.52"	5746	8115	14019	18066	25456	43520
4"	014563	2.84"	7699	10869	18766	24176	34043	58081
4"	015511	3.154"	10233	14440	24911	32076	45120	76704
6"	015723	1.95"	3150	4451	7698	9926	13999	23989
6"	015724	2.25"	4218	5962	10309	13293	18746	32120
6"	015725	2.6"	5689	8040	13902	17924	25274	43299
6"	015672	3"	7700	10880	18810	24250	34191	58552
6"	014566	3.85"	13462	19015	32855	42343	59665	102001
6"	015726	4.4"	18745	26467	45701	58875	82896	141349

Notes:

1) Orifice bore size equals the orifice plate inside diameter. All bore sizes in inches. Sizing based upon Schedule 40 pipe.

2) Capacity based on 60°F at 5 psig upstream pressure. Natural gas specific gravity of 0.60.

3) All flow rates listed at standard conditions – 14.7 psia, 60° Fahrenheit.

Table 3 – Companion Flange Parts Table

Companion flanges include a pair of flanges, gaskets and fasteners.

Pipe Size	Part Number
3"	140874
4"	140875
6"	140876

Table 4 – Correction Factors

The capacities listed in Table 2 are listed at 60°F and 5 psig upstream pressure (specific gravity for natural gas 0.60). When these conditions are not present, corrections must be applied to the listed flow rate.

Upstream Pressure (psig)	Natural Gas Temperature						
	30	40	50	60	70	80	90
0.5	0.90	0.89	0.89	0.88	0.87	0.86	0.85
1	0.92	0.91	0.90	0.89	0.88	0.88	0.87
2	0.95	0.94	0.93	0.92	0.91	0.90	0.89
3.5	0.99	0.98	0.97	0.96	0.95	0.94	0.93
5	1.03	1.02	1.01	1.00	0.99	0.98	0.97
7.5	1.09	1.08	1.07	1.06	1.05	1.04	1.03
10	1.15	1.14	1.13	1.12	1.11	1.10	1.09
15	1.26	1.25	1.24	1.23	1.22	1.20	1.19
20	1.37	1.35	1.34	1.33	1.31	1.30	1.29
25	1.46	1.45	1.43	1.42	1.40	1.39	1.38
30	1.55	1.53	1.52	1.50	1.49	1.48	1.46
40	1.71	1.70	1.68	1.66	1.65	1.63	1.62
50	1.87	1.85	1.83	1.81	1.79	1.78	1.76
60	2.00	1.98	1.96	1.95	1.93	1.91	1.89
70	2.13	2.11	2.09	2.07	2.05	2.03	2.01
80	2.26	2.23	2.21	2.19	2.17	2.15	2.13
100	2.48	2.46	2.43	2.41	2.39	2.37	2.34

Instructions:

1) Record the differential pressure reading from the orifice plate
2) Find Q.Std, or standard flow rate, through the orifice plate in Table 2.
3) Find Corr, or the pressure and temperature correction factor, in Table 4.
4) The compensated flow rate through the orifice in SCFH is calculated using equation (1) below.

(1) $Q=C_{corr} \times Q_{std}$

Correction Factor Calculations

The method to determine the correction factor is shown below. It is the same method used to build Table 4.

Upstream Pressure

For an upstream pressure other than 1 psig, determine the appropriate correction factor for upstream pressure using equation (2), then determine the correct flow using equation (4).

$$(2)\ C_{Pressure} = \sqrt{\frac{P2+14.7}{P1+14.7}}$$

$C_{Pressure}$ – Upstream Pressure Correction Factor
P1 – Table 2 Upstream Pressure: 1 psig
P2 – Recorded (Actual) Upstream Pressure (psig)
Note: 1 psig = 27.7”w.c.

Fluid Temperature

Fluid temperature refers to the temperature of the gas within the pipe (natural gas, typically). For a fluid temperature other than 60° Fahrenheit, determine the appropriate correction factor for temperature using equation (3), then determine the correct flow using equation (4).

$$(3)\ C_{Temperature} = \sqrt{\frac{T1+460}{T2+460}}$$

$C_{Temperature}$ – Fluid Temperature Correction Factor
T1 – Table 2 Fluid Temperature: 60° Fahrenheit
T2 – Recorded (Actual) Fluid Temperature (degrees Fahrenheit)

Correction Factor Equation

The correction factor equation (4) is similar to equation (1), but the temperature and pressure correction factors are separated. Q.std is determined from the differential pressure reading from the orifice plate and Table 2.

$$(4)\ Q = C_{Pressure} \times C_{Temperature} \times Q_{std}$$

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